unusual type of liver tumor—angiosarcoma—was reported in 1974. The accumulated reports of an increased risk of hepatic angiosarcoma associated with an antecedent exposure to vinyl chloride have achieved almost the same degree of acceptance in current medical wisdom as the association between mesothelioma and asbestos. Just as asbestos causes more cancers than mesothelioma, however, the carcinogenic activity of vinyl chloride is much broader than hepatic angiosarcoma. After absorption, it is metabolically converted to chloroethylene epoxide, which is highly reactive and binds covalently to nucleic acids, increasing the mutation rate in any tissue that can support this metabolic change. On this basis, it is not surprising that a 1981 review of the epidemiologic studies of workers exposed to vinyl chloride has shown a significant excess risk in four of eight studies of biliary and digestive system cancers, in five of eight studies of brain tumors, in three of eight studies of respiratory system cancers, and in one of five studies of lymphatic and hematopoietic system cancers. A more recent 27-year study of exposed workers in Norway reported only a single case of hepatic angiosarcoma but an increased risk of colon cancer, lung cancer, melanoma, and thyroid cancer.

The experimental and epidemiologic evidence for the carcinogenicity of vinyl chloride monomer is solid, but appropriate protective measures continue to be overlooked frequently. Because a large proportion of plastics manufacture takes place in plants too small to retain their own medical staff, it follows that many, if not most, cases of cancer associated with this gas will first come to the attention of nonoccupational-medicine physicians who need to be aware of the growing data base linking exposure to vinyl chloride and an expanding array of cancers. As was the case for asbestos, such medical recognition is likely to be essential to the achievement of effective exposure control.

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Recognizing the Health Hazards of Ethylene Oxide

ETHYLENE OXIDE (C_2H_4O) is an important industrial chemical used in sterilization and many manufacturing processes. At ambient temperatures, it is a gas. In vivo, it is rapidly distributed throughout the body. Short- and long-term exposures lead to respiratory tract irritation and may lead to central nervous system depression and seizures. At high concentrations, ethylene oxide can induce lethal mutations and cause embryotoxicity in rodents. It is able to alkylate DNA-causing gene mutations leading to sister chromatid-exchange abnormalities and chromosomal damage. Several types of tumors have been described in laboratory animals associated with ethylene oxide exposures.

Five longitudinal epidemiologic studies in occupationally exposed workers in Sweden, the United States, and West Germany strongly support the association of the agent with leukemia. The data cannot be considered conclusive, as the number of workers is relatively small and it is impossible to exclude completely exposure to other workplace carcinogens. Nevertheless, these epidemiologic studies strongly suggest that ethylene oxide is carcinogenic in humans. Studies of hospital workers with long-term ethylene oxide exposure, when compared with control populations with no significant difference in educational background, suggest that neurologic dysfunction may result from such exposure. These effects may occur at exposure levels that are common in hospital sterilizing procedures. The use of ethylene oxide is primarily limited to the sterilization of medical and food products.

Because the safe level of exposure to this agent is difficult to define, persons working in close proximity to hospital, laboratory, or food sterilizers should be informed as to the known and the uncertain risks. The function of sterilizing equipment should be regularly assessed to ensure there is no human exposure. The rationale for both environmental and medical surveillance needs to be presented to all potentially exposed persons.

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Carcinogenicity of Synthetic Mineral Fibers

SYNTHETIC MINERAL FIBERS such as fiberglass and mineral wools have assumed significant industrial importance and currently represent a $3 billion domestic industry. The durability, strength, and insulating properties of these fibers allow them to serve a wide variety of purposes, including insulation and structural support. Recognized health risks associated with synthetic mineral fibers include respiratory and skin irritation. They have been considered safe from the standpoint of cancer risk, making their use attractive in applications previously limited to asbestos fibers. Recent epidemiologic data suggest, however, that synthetic mineral fibers may be associated with increased lung cancer risk.

Concern over possible carcinogenic effects was raised in the early 1970s when it was shown that mesotheliomas could be caused in animals by instilling vitreous fibers into the pleural space. Fibers that were long, thin, and durable showed a carcinogenic potential equivalent to asbestos. Inhalation studies in animals, however, which probably represent a more appropriate model of human exposure, did not show these fibers to be carcinogenic or significantly fibrogenic.

Epidemiologic studies in human populations have also raised important questions regarding the health risks associated with synthetic mineral fibers. An increased prevalence of minimal interstitial changes has been found in chest radiographs of insulation plant workers exposed to these fibers. A large cooperative European study of more than 20,000 workers employed in the industry since the late 1930s showed an excess of lung cancers. Subjects whose first exposure occurred more than 20 years before the diagnosis of cancer and who began work in the early technologic phase of the industry's development were most strongly affected and had about a twofold increased lung cancer mortality. Similar results were reported among American workers in the industry. In comparison, lung cancer deaths among asbestos workers are increased fivefold in nonsmokers and 50-fold in smokers. Insufficient data are available to address the role of smoking

for patients with lung cancer associated with synthetic mineral fiber exposure. Malignant mesothelioma has not been linked to such exposure.

Excess lung cancers in these studies appear concentrated in groups that began working in the industry before protective measures, such as dust suppression, were widely introduced, which probably have significantly reduced exposure for contemporary workers. If the potential of these fibers to cause lung cancer is dose-related, as is the case for asbestos, then it is likely that less risk accrues to today's workers and that the danger to homeowners with attic insulation of synthetic mineral fiber is negligible. Measures to minimize exposure should be consistently and conscientiously applied, however, to avoid the tragic health and economic consequences associated with occupational exposures to asbestos.

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Preplacement Medical Examinations—Update

THE PREPLACEMENT MEDICAL EXAMINATION provides physicians with an opportunity to make an assessment of a job applicant's health risks through an examination of that person's past and present state of health. Federal regulations mandate that all employment medical recommendations be job-related. There has been a 10.5% increase in preplacement medical examinations throughout the country since 1975. Research examining their use has found that only 25% of the physicians who do these examinations have ever visited work sites to become familiar with the jobs. A large minority do not even refer to the job descriptions before making employment recommendations. A reluctance to address the "job-relatedness" of the medical evaluation places both the reliability and validity of these recommendations in question.

Although all decisions regarding employment recommendations require a thorough evaluation, making employment recommendations is extremely difficult when applicants have preexisting medical conditions that could affect their ability to safely do a job that is physically demanding. For these types of jobs, preplacement medical examinations are largely directed at detecting problems associated with the low back because those who have had one incidence of low-back pain are likely to have another. Additional studies have shown that a low cardiovascular fitness level is a risk factor for chronic back pain and can be detected during the examination.

If preplacement medical examinations are used as employment selection tools, they must conform to the federal regulations that mandate that employment selection procedures be based on job-related criteria. It is the burden of an employer to show that the medical standards used are indeed job-related. The burden this places on physicians is one of making an "informed" decision, which requires knowledge of specific tasks that will be required of a job applicant. This information is often synoptically presented in the job description and class specification, but the generality of these documents may be of limited value to a physician in making appropriate recommendations. The alternative is to evaluate an applicant using job-related information that has been collected through analyzing the most physically demanding or hazardous and essential tasks within a specific job. This information allows the physician to base the recommendation on an evaluation of the applicant's medical condition as it relates to the minimum physical abilities required to safely do the job.

An effective resolution of problems associated with the preplacement examination may require a comprehensive program consisting of strength and fitness testing and a medical examination developed on a job-related basis. Many public and private organizations currently meet these criteria. Though empirically unproved, these programs have a good potential for decreasing the incidence of job-related injuries and illnesses that may be caused by improper placements in various positions.

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What We Have Learned From Chernobyl

THE CHERNOBYL DISASTER of April 26, 1986, tested the ability of the Soviet medical system to provide emergency medical care in a civilian nuclear disaster of unprecedented scope. Within 12 hours, medical "brigades" composed of about 3,000 physicians and 2,400 nurses, paramedics, and laboratory technicians had been transported to the nuclear reactor village from as far away as Moscow (640 km [400 mi]) and beyond. The on-site medical emergency team was sorting out those firefighters who required hospital admission within 15 minutes of the explosion. By four hours, 108 of 204 of the firefighters were admitted to hospitals. By the end of two days, more than 350 victims of acute radiation sickness had been evaluated, medical charts assembled, and 1,000 leukocyte counts and differentials done to estimate radiation doses. Ultimately 203 seriously irradiated— > 199 rads—and thermally burned patients were admitted to hospitals in Moscow (129 patients) and Kiev (74 patients).

Despite state-of-the-art therapy that included bone marrow transplantation, 27 of 42 patients—19 patients with more than 600 rads total-body radiation dose and 23 patients with 400 to 600 rads total-body dose—died in hospital. (Two reactor operators died or were lost within six hours of the blast.) Of 171 patients with acute radiation sickness of less severity—dose estimates 100 to 400 rads—none died. All deaths were associated with severe thermal and β-radiation burns of the skin and upper respiratory system, injuries that are known from experiments in animals to enhance the lethality of otherwise tolerable radiation exposures. The rapid identification made under austere conditions of 203 among 24,000 persons exposed to clinically significant levels of total-body irradiation who required hospital admission and the